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3110/3120/3130

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3110/3120/3130 DATAPLOTTER

INFORMATION GUIDE

ELECTRONIC ASSOCIATES, INC.
Long Branch, New Jersey

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SECTION I

GENERAL

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INTRODUCTION

This brochure is intended to be a basic introduction to the new 3110/3120/3130 DATAPLOTTER Series. It is our hope this material will enable all those concerned with the marketing of these units to understand their operation -- and to appreciate their capabilities.

In order that those who are not familiar with the DATAPLOTTER might become familiar with its history and its evolution, perhaps it is best to review EAI and its connection with DATAPLOTTERS. This review should serve to educate all concerned as to the relationship between the various DATAPLOTTER units.

HISTORY OF THE DATAPLOTTER

DATAPLOTTER is a trade name belonging to Electronic Associates, Inc. and denotes a complete line of digital plotting equipment.

The DATAPLOTTER was a logical development of the X-Y plotter line which EAI produced in 1946. It was in that year the first commercially available X-Y plotting board was delivered. The first digital plotting unit was produced for the United States Navy in 1951. It is an X-Y plotter capable of point plotting digital information fed from a punched paper tape. This particular unit is still in operation at the Naval Ordnance Test Station, China Lake, California, and many "Digiverters", as the unit was called, are still in service.

EAI's next development in the digital plotting field was a line plotter capable of drawing a straight line between two points. This system operated from punched cards, punched paper tape and from a manual keyboard. The next logical

step in advancing the digital plotting art was the inclusion of magnetic tape input. This aim was accomplished in 1959.

With the advent of the magnetic tape input capability, the art of digital plotting advanced rapidly. Over 50 EAI magnetic tape DATAPLOTTERS are now in use throughout the world; serving science, business and industry. Magnetic tape input to the DATAPLOTTER has provided the key to high speed, accurate graphic display of digital data. To obtain a graphic plot of data in digital form, it is only necessary to present this data to a DATAPLOTTER in the prescribed format.

In 1963, Electronic Associates introduced two new DATAPLOTTERS; the 3500 and the 3110/3120/3130 Series. Both of these systems were the result of updating and expanding the capability of former products.

The 3500 DATAPLOTTER is a completely solid state version of the 3300 DATAPLOTTER. It incorporates high speed, modular construction and simplified design into an extremely versatile unit capable of operation on-line with a computer or off-line from magnetic tape, punched cards or punched tape.

The 3110/3120/3130 Series DATAPLOTTERS provide an updating of the 3100 DATAPLOTTER. These systems are completely solid state and use the new 1110 VARIPLOTTER as a plotting surface. These systems provide point plots (3110), line and point plots (3120) from cards or punched tape or operate on-line with a digital computer (3130). The produced plot is limited to 10 by 15 inches in size.

Electronic Associates, Inc. has strived to maintain its leadership in the field of digital plotting by product improvement and development of needed accessories.

GENERAL

The 3110/3120/3130 Series of DATAPLOTTERS is a natural adjunct to the existing DATAPLOTTER line at EAI. This series is basically an expansion and redesign of the 3100 DATAPLOTTER including repacking, substituting the 1110 board for the 1100E plotter and adding a line drawing capability.

It is probably well to remember when considering the 3110, the 3120 or the 3130 that all are basically the same unit. The 3110 unit offers the most basic package with the most restricted capabilities. The 3110 is a point plotter only and operates from IBM card or punched paper tape. The 3120 is the same package as the 3110 with the line drawing capability added. This means the 3120 is not only a point plotter but also has line drawing capabilities. What then is a 3130? A 3130 is either a 3110 or a 3120 with interface for direct on-line operation from a computer. The interfacing will vary from computer type to computer type (1620, 1401, 160, 1604, etc.) but, basically, the interface will be "that circuitry which enables the DATAPLOTTER to accept data as presented by the computer within the limits of the plotter's ability to process".

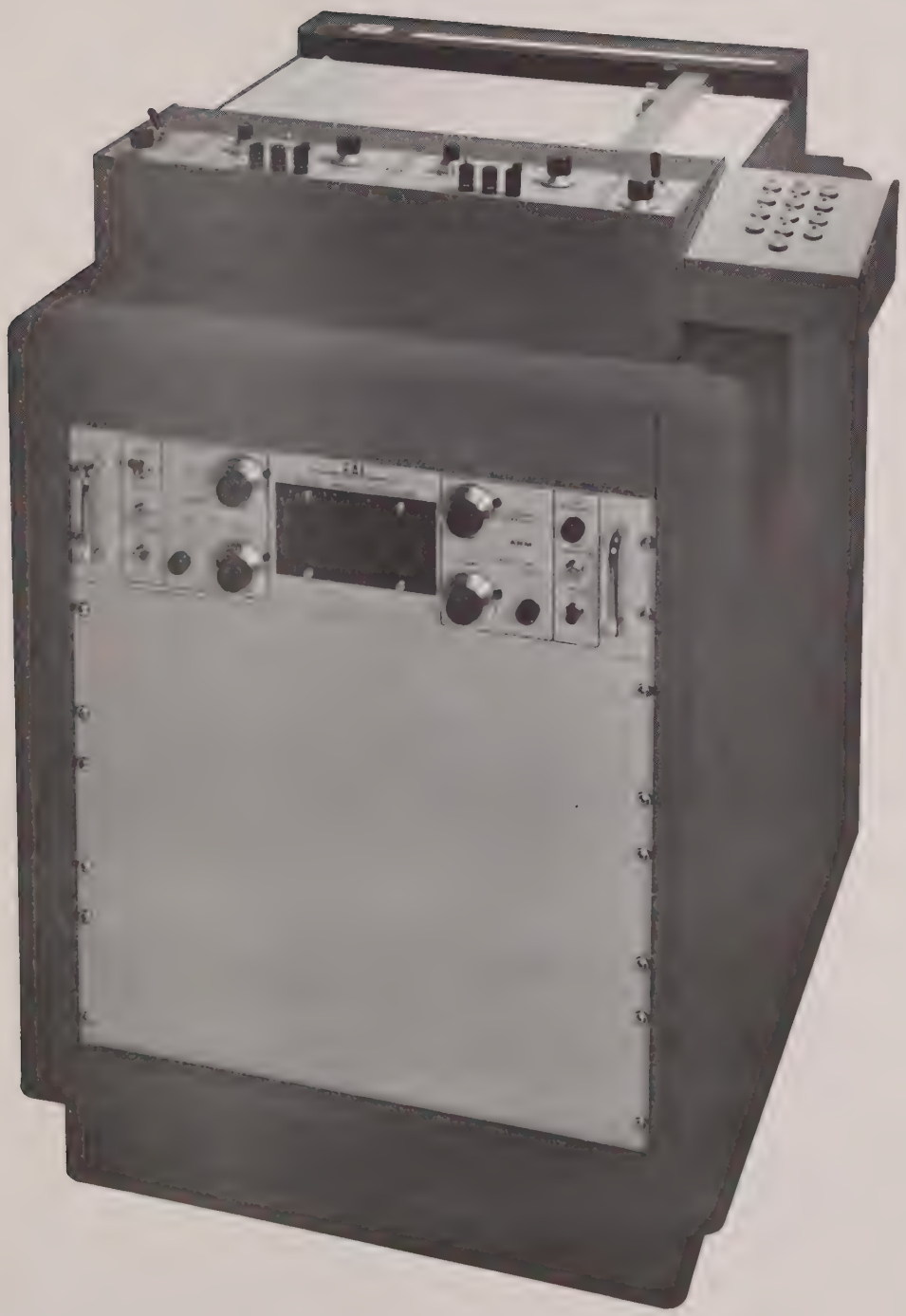
WHAT DO THEY DO?

The 3110 DATAPLOTTER (see illustration), being the most basic unit, prepares point plots of data presented to the plotter in decimal form from IBM cards or from data presented in BCD form from punched paper tape.

The 3110 will proceed to the coordinate presented by the input media and the pen will drop -- making a .015" dot of ink -- and then raise automatically. The pen is lowered and raised by a positive null sensing circuit which

monitors the difference between the position defined by the input data and the actual position of the pen, causes the pen to move to the position defined by the input data and register a discrete dot. When the pen is raised, the input device (card reader or tape reader) is allowed to read the next point.

The 3120 (see illustration) not only has all the features of the 3110, it also has a line drawing capability. The choice between point and line plotting is made by the operator by means of a control panel switch. In the line drawing mode, once a point is defined, the plotter will proceed between that point and a new coordinate point by a straight line which is ideally straight between end points to .020". The length of these lines can be anything within the limits defined by the plotter filter networks. Originally, we quoted 5-inch lines and 1-inch lines which are classified as long and short line segments. Investigation, however, has indicated this is not practical from a user's point of view, since they indicate it is not often you have a 5-inch line in a 10 by 15-inch plot. We are now making 2-inch lines and 1/4-inch lines standard, since these appear to be the most functional limits. It should be borne in mind, however, any line length filters can be provided, but the plotting time will vary with the length of the maximum line. It should be understood the speed of "point" plotting is determined by the rate at which nulling is achieved and the speed of "line" plotting is fixed and is dependent on line length. When a line length is decided upon, a filter is designed to meet the accuracy and linearity specs of the system. This filter inherently will have certain fixed time constants which will determine the rate at which lines of that length can be drawn. Once



3110 DATAPLOTTER

3120 DATAPLOTTER

the time for drawing -- or time for movement of pen and arm -- is determined, the line drawing rate is set within the equipment. The timer within the unit tells the input device when it should read in the next data point.

NOTE: The length of line which can be drawn is a function of filter design, while time of drawing is a function of the acceleration and velocity characteristics of the 1110. A short line filter can be used when drawing a long line, but the quality of line deteriorates with the increase in speed.

Conversely, a short line can be drawn using the long line filter with an increase in line quality, but with a corresponding decrease in speed.

It is also pointed out that by speed it is meant the number of line segments per minute. Short line speeds are approximately 70 lines per minute long; long speeds are approximately 55 lines per minute.

The 3130, as was stated before, can be either a 3110 or a 3120 to which additional circuitry has been added to enable the unit to receive information directly from a computer and also to enable the unit to tell the computer when to transmit data and when not to transmit data.

The concept of matching data lines to the various computers is important, since each computer must transmit data bits into impedance levels which are acceptable. Also, it must be remembered all computers have their own output rate which must be matched to that of the plotter. In some cases, this requires a storage register between the computer and the plotter.

HOW DO THEY WORK?

Figure I shows the major components of the 3110/3120/3130 DATAPLOTTER systems. The DATAPLOTTER is designed to accept inputs from three different sources; the IBM Type Summary Punch, the Commercial Controls Corporation tape reader or the 9.025 Control Panel Keyboard. The tape reader output is binary-coded decimal, and the card reader and the keyboard outputs are common decimal.

The Digital-to-Analog Translator accepts both BCD and decimal inputs, converting the common decimal to BCD and stores this data until required by the plotter for recording. The storage units of the translator perform a two-fold function; that of storing the data plus converting it from BCD to an analog current equivalent.

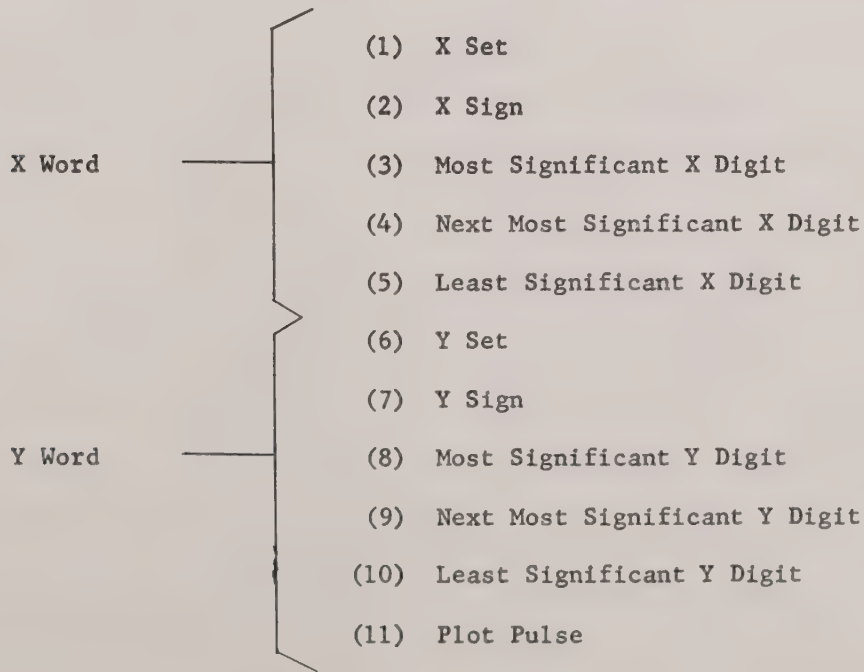
The TR-5 circuits convert the analog current to a scaled analog voltage for application to the 1110 VARIPLOTTER. A temporary storage circuit is provided in the TR-5 which permits the translator to release its old data and receive new data while the plotter is in the process of recording the old data. The TR-5 contains a third order active data filter network when the line plot capability is included. This filter maintains the plotter in the tracking mode between points rather than the slewing mode.

The 1110 VARIPLOTTER portion of the system records the analog data as received from the TR-5. The pen control signals for both line and plot mode are received from the translator. The translator receives a null signal from the plotter to indicate when the plotter is ready to receive new data.

The 3110/3120/3130 DATAPLOTTER functions basically in the same manner with each of the three types of inputs. There are, however, differences in the unit operation for each type of input; thus, the following paragraph describes the operation of the DATAPLOTTER with the keyboard input in detail and then indicates the variations in this operation for tape and card reader inputs.

A. Keyboard Input (Figure II)

The keyboard feeds data into the translator over 15 separate leads: X set, Y set, 0 through 9 digits, clock pulse, plot pulse, and a reset pulse inputs. The translator converts these signals, with the exception of the clock, plot and reset pulses, into BCD codes. The translator is designed to accept the BCD codes serially; thus, although the keyboard signals are wired to the translator in parallel, each character must be entered serially and in a definite order. The required order is as listed and is the same as that for punched paper tape.



The only change permissible to this format is the interchanging of the X and Y words. For this discussion, it is assumed X word is inserted first.

Depressing the X set key applies a +40 volt pulse to the decimal-to-BCD converter and then as a 8-4-1 BCD code -- the X set code -- to the command data inverter. The inverter applies both this BCD code group and its complement to the command decoder. The command decoder detects the X set signal and performs three functions: a reset pulse is sent to the impulse counter (similar in operation to a stepper switch), the old data is cleared from the X matrix, and a hold signal is sent to the TR-5 sample and hold circuit to temporarily store the old data until the plotter can record it. As the operator releases the X set key, a +40 volt clock pulse is generated and sent to the keyboard clock pulse network. The clock pulse network performs two functions: it delays the clock pulse slightly to assure that the three operations performed by the X set code are completed and it causes the impulse counter to step to position one. This position of the counter decoder indicates to the translator that the next character determines the sign of the X word.

The operator indicates the sign by depressing the 0 key (positive) or 1 key (negative). Note the zero code is not sent to the translator, only the one code; thus, if a one digit is inserted the polarity decoder sets the X matrix for a negative word, otherwise the matrix sets up for a positive word. However, even though the zero key does not actually send a pulse to the translator it must be depressed since its release

(as does the release of the 1 key) generates a clock pulse. The clock pulse steps the impulse counter to the next position which indicates the next character is the most significant X digit. Each of the three significant X digits as they are inserted also generate clock pulses; each time the impulse counter is stepped, it informs the translator of the significance of the next digit. Therefore, as in the case of the sign code, although a zero code has no effect on the translator, the zero key must be depressed to generate a clock pulse to step the impulse counter. For example, if a range of 1 to 100 counts is to be applied to the X axis, the 1 count must be considered as 001. In both cases, the zeros -- the two preceding the 1 count and the two suceeding the 100 count -- must be entered so the impulse counter steps to its proper position. In the case of the X = 100 counts, if the zeros are neglected and the Y set key is punched the X 10's matrix will record the Y set 8-4-2 BCD code.

The Y set code effects the translator in a similar manner as outlined for the X set code, except the old data is cleared from the Y matrix and the command decoder Y distribution relay indicates the impulse counter data concerns the Y channel. The Y sign and significant digits are detected by the translator in a similar manner as outlined for the X word.

Up to this point in the operation, the plotter is positioned to a point defined by the old data stored by the TR-5 sample and hold unit, the new data has been decoded and converted by the

translator, and the plotter is ready for new data. To record new data, the operator must depress the PLOT key.

The plot pulse, one of the pulses not converted to BCD, triggers a detector in the command decoder which, in turn, relays the plot pulse to the control unit. The control unit, sensing the status of the plotter through the null signal circuits, waits until the plotter attains a null, then issues a plot command. The plot command momentarily drops the pen to the plotting surface recording the new point. When the operator presses the X set key, the cycle is repeated.

The RESET key has not been mentioned thus far, since it normally only is used in conjunction with the tape and card reader inputs. This key is used when erroneous data (assuming proper scale factor setting) causes a point to fall off the plotting surface. As indicated in the previous paragraph, the control unit will not issue a plot command until the plotter nulls; if the point is off the plotting surface the plotter cannot null. Until the plotter nulls, interlock systems prevent raw data from being inserted by the tape or card readers. Pressing the RESET key overrides the plotter null signal, forces a plot, thus releasing the tape or card reader to insert the next data group. This key can also be used when inserting data from the keyboard; however, since the keyboard is not interlocked, pressing the X and Y set keys removes the old data, essentially overriding the null signal. New data is then inserted in the normal manner.

Line plotting can be accomplished using the keyboard input. The keyboard does not have pen up and pen down control keys; thus, the operation controls the pen with the VARIPLOTTER PEN-ARM switch. To do this, the plotter LOCAL-REMOVE switch must be placed in the LOCAL position; all other controls are placed in the normal line plot position. In the line plotting mode of operation, the null sensing circuits are disabled.

B. Tape Reader Input

Comparison of Figures II and III indicates the similarity in operation of the DATAPLOTTER with either the keyboard or tape reader inputs. With the tape reader input, the decimal to BCD converter is eliminated since the tape input is already in the BCD form. The keyboard clock pulse network is also eliminated because the tape reader generates a clock and, also since the tape clock leads each input character, there is no need to delay the pulse. Added to the tape reader circuit is an interlock system, which prevents data from being inserted faster than it can be plotted, and pen control circuits for line plotting operations. In all other ways, the DATAPLOTTER operation with tape input is essentially the same as described for the keyboard.

C. IBM Card Reader Input

Figure IV shows the 3120 DATAPLOTTER block diagram, although this system is similar to both the keyboard and tape reader circuits, the card reader is unique since it provides its own coincidence pulses. For this reason, the impulse counter is not required. The card reader also presents the problem, although the input data

is received in a parallel manner similar to the keyboard, the X and Y significant bits are not received serially. That is, since the card punches are staggered on the card due to the varying magnitude of each character and since the emitter wheel sends in the digit characters serially (0 through 9), frequently the least significant bit of either or both the X and Y channels are received first. The R row punch brush of the card, therefore, is not connected to the translator and the R input of the emitter wheel is used to clear both the X and Y matrix simultaneously. This signal, like the X set (or Y set) places the TR-5 in hold, storing the old data.

The X row, which is read next, determines the polarity of the X and Y data simultaneously. When the X and Y digits are received, the matrix can accept these digits in any order since each digit is provided with its own coincidence pulse to assure it is channeled into the correct storage area of the matrix.

When the card reader has completed its reading cycle of a card, it generates a read complete signal; this signal is used as the plot pulse by the translator. Note -- even though the significant digit characters are not received serially -- the overall input sequence is serial in nature, i.e., the matrix clear (and temporary TR-5 storage of old data), the sign data, the digit characters, and the plot pulse are received in that order.

THEORY OF OPERATION

This paragraph describes the operating sequence of the 3120 DATAPLOTTER with a tape reader input. (The tape reader utilizes all of the translator circuits except the decimal to BCD converters.) Differences between the tape, IBM and keyboard operation are described in sub-paragraph B and C.

Figures V through VII form a complete flow-diagram for the DATAPLOTTER with a tape reader. The hexagon-shaped blocks indicate interconnections between figures; like numbers form continuous paths. Diamond-shaped blocks are decision blocks indicating where a choice of two or more conditions may occur; the decision made by the DATAPLOTTER may be determined by relay states, detector (or decoder) circuits, or switch positions. The remaining rectangular blocks are event blocks which briefly describe the operations between equipment decisions.

A. Tape Reader

The tape input format is described in the addendum of this brochure; however, the following points are given to help clarify the following description. The X word consists of the X set code followed by the sign code, 100's, 10's, and units characters in that order; the Y word has a similar make up. These words must be entered sequentially in their entirety and should not be broken up in any manner. The plot pulse is always the last data character in a code group describing a point. The pen command code (used only in line plotting), may be the first character in the group or it may come just before the plot pulse (actually it could also be inserted between the complete X and Y words); in this description, it is assumed this is the first character of the overall code group.

The tape reader is initially started by the operator placing the AUTO-MAN switch in the AUTO position (top of Figure V). If the unit is in the line plot mode and a pen command code is entered, the pen mode relay in the command decoder and gate distribution unit is energized (pen down) or de-energized (pen up) as the case may be. If the unit is in the point plot mode, even though a pen command is entered, it is ignored.

Following the pen command is the X or Y set code; the DATAPLOTTER determines which input is received as indicated by the second decision block of Figure V. If the X set is received, the five functions indicated in the X set path event block are performed.

The previous data, which is held by the sample and hold amplifier in the TR-5, will be retained even though the plotter nulls and plots the point. The new input data is held until the new data is released to the sample and hold circuit.

Once the X set cycle is complete, the tape reader is released and permitted to free run through the remainder of the X word. Thus, as the sign and significant characters are received, they are immediately stored and guided to the proper place by the impulse counter via the X distribution relay. The impulse counter is stepped to the proper position by the clock pulses preceding each character. The tape reader is not stopped again until a Y set or plot pulse is entered. The Y set code effects the translator in a similar manner as the X set code as shown in Figure V.

The operation of the DATAPLOTTER after a plot code is received is outlined starting at the top of Figure VI. When the plot pulse is received, the plot relay is energized and the tape reader is stopped and remains stopped until the plot relay is de-energized. Once the plot relay is energized, the operation of the plotter is a function of one of two conditions; when in the point plot mode the null detector, while in the line plot mode the timer. In the line plot mode, the pen responds to the command of the pen control relay. In the point plot mode, the pen responds automatically to the null sensing circuit dropping momentarily to register a point.

The pen control relay is set upon command from the tape, a pen up command causes the pen control relay to be energized and pen down command causes this relay to de-energize and the pen to drop. At the expiration of the timer period, or at the sensing of a null, the data in the X and Y registers is sampled and the pen and arm allowed to move to a new coordinate point.

During the time the sample and hold circuit is sampling new data, the plot relay is de-energized allowing the tape reader to advance reading new data into the DATAPLOTTER.

Once the sample and hold relay samples the new data, this information is applied to the plotter. In the line plot mode, it is applied through an active filter network which assures a straight line plot between points. As the plotter servos toward the new point, new data can be inserted since an X or Y set places the sample and hold

amplifier in hold permitting the matrix to be cleared. In point plot mode, the active filter circuit is eliminated and the amplifier in that circuit becomes a gain-of-one amplifier.

B. Keyboard Input

The keyboard operation is very similar to that described for the tape reader. The keyboard does require the use of the decimal-to-BCD converter. Since pen commands cannot be inserted via the keyboard, the pen must be operated manually in line plot operation. There is no interlock system between the translator and keyboard; however, due to the speed of the plotter and the necessary time required to insert data via the keyboard, interlocks are not necessary. Thus, the line plot operation and X and Y set relay cycle complete decision blocks on Figure V can be eliminated for keyboard operation. In addition, the answer to the decision block is the plotter at null, can be considered as yes for practically all keyboard situations.

C. Card Reader Input

Unlike either the tape or keyboard inputs, the card reader clears both matrix at once. Since the card reader supplies both the coincidence and magnitude pulses, it is not necessary to use the impulse counter. In addition, only one relay is involved in clearing the matrix; thus, it is not necessary to stop the card reader once it starts, until a plot pulse is received. The card reader plot pulse is actually the card finished-reading pulse; therefore, once a card is started in the reading process, the card reader runs through the complete read cycle.

SECTION II

PROGRAMMING AND INTERFACING DATA

INPUT DATA GENERAL

The 3110/3120/3130 Series DATAPLOTTER will accept data from paper tape and IBM type cards. It is essential that certain rules be followed in preparing the data. These rules, when followed, present data in a form most acceptable to the DATAPLOTTER. We say most acceptable, since certain exceptions can be made if the equipment is modified, but the basic system requires that the input data conform to the EAI format.

PUNCHED PAPER TAPE

The standard punched tape reader used with the 3110/3120/3130 Series is the Friden mechanical reader modified for use with the DATAPLOTTER. This reader will accept tape which may vary in width from 5 to 8 columns. The reader only monitors six of these columns, therefore, punches in the seventh and eighth columns normally do not enter the DATAPLOTTER.

The instructions the translator receives from the tape reader are in sequential order due to the nature of the tape. To discriminate between the X and Y coordinate data, the translator requires an X set and a Y set command code. In addition, the translator also requires a plot command to indicate that the data concerning a coordinate has been inserted and can be plotted.

Figure I illustrates how the various instruction codes and numerals required by the translator would appear when punched on a tape. The sequential nature of the tape reader operation dictates these codes must be punched to a definite format.

The required format is as follows:

(1) X set

(2) X sign (decimal one for negative, 0 for positive value)

(3) X 100's (most significant figure)

(4) X 10's (next most significant figure)

(5) X 1's (least significant figure)

(6) Y set

(7) Y sign (decimal one for negative, 0 for positive value)

(8) Y 100's (most significant figure)

(9) Y 10's (next most significant figure)

(10) Y 1's (least significant figure)

(11) Plot

Should there be additional characters between the X data and the Y set character, between the Y data and the plot character or after the plot character, they will not effect the machine operation. Data can only be entered in the X axis after an X set and in the Y axis after a Y set. The entered data can only be acted upon after receipt of a plot.

Figure I is intended as a guide to proper tape formating. The tape is laid out in a straight format in a standard binary code decimal (BCD) coding. As can be seen from Figure III, other codes are available but in comparing them with the standard BCD code it should be obvious these codes cannot be used without modification of the DATAPLOTTER.

The four codes shown in Figure III are used most often for punched tape. Other codes are used for certain computers (Datatron, IBM 1620, Monorobot) but, in general, it can be stated they most nearly approach the excess three code if they are other than straight binary.

CARD INPUT

The 3110 and 3120 DATAPLOTTERS will operate from IBM card readers such as the 407, 514, 519 and 523 which are parallel card readers, and the 024, 026 and 526 which are serial card reading machines.

It is well to understand parallel card readers have certain distinct advantages over serial card readers. From an operational point of view, the parallel readers are faster. They read an average of 100 cards per minute as opposed to 70 for the serial reader. The serial reader does have the advantage of allowing more than one data point to be placed on a card, but modification to serial readers to be used with a DATAPLOTTER is extensive when compared to what is required for parallel readers. (See PACE Technique 19-4 attached)

Card formats for the serial and parallel machines are shown on the following pages. Since most parallel readers have a patch panel, it is possible to select data from any column or columns on the card. Since only the 526 has a patch panel in the serial reader class, a serial card format is more or less fixed. In both readers, however, the data is read from the card in decimal form and converted to its binary code decimal (BCD) in the DATAPLOTTER. Not all commands used for paper tape or keyboard data entry are necessary when using cards. Only the sign and digital value need appear on a card, the X set and Y set are handled within the DATAPLOTTER, while the plot pulse is generated by the card reader. When using a serial card reader, a program card is needed to indicate a plot while in the parallel reader a plot pulse is generated when the machine has finished reading the card -- it is a function of the card complete pulse.

SECTION III

COMPETITIVE SITUATION

GENERAL

The Series 3110/3120/3130 DATAPLOTTER enters the market in direct competition with the CalComp eleven-inch incremental recorder. It cannot be said it competes against the Dymec unit since it does not have magnetic tape capabilities, nor against the Benson-Lehner Miniplotter for the same reason.

Since the CalComp unit is by far the most serious competition the 3110/3120/3130 DATAPLOTTER faces, most of this write-up will be devoted to these two systems; however, in passing it might be well just to compare the DATAPLOTTER with the Dymec and Benson-Lehner plotters. This is done on the attached sheet. This sheet is meant as a short form review; a more comprehensive comparison can be made by making use of the attached competitive literature. A comparison sheet for the CalComp unit and the DATAPLOTTER is included in this write-up, but in order to make a comparison more meaningful to those who have little or no digital plotting experience, the following notes have been compiled.

PHILOSOPHY

A DATAPLOTTER will seek a coordinate point defined by X and Y digital information which has been converted -- in a Digital-to-Analog Converter (DAC) -- to an analog voltage. This is a positive motion and the pen will be positioned to within .010" of the true data position. This positioning is repeatable to .003".

A CalComp incremental plotter, on the other hand, does not consider a data point as a coordinate pair but rather as a point which is so many steps -- or increments -- removed from the point at which the plotter was last stopped. This is more readily understood when one considers that the drum, which is

comparable to the arm on a DATAPLOTTER and the pen, which is about the same as a LeRoy pen on a DATAPLOTTER, move independent of one another in steps of .010". This means then, in order to move to a new point diagonally one inch away from a given point, the CalComp plotter must be given just enough commands to cause the drum and the pen to independently arrive at the desired point simultaneously. Unless the point is exactly an even .010" or even multiples away from the last point, it cannot be reached.

PROGRAMMING PROBLEMS

Since DATAPLOTTERS accept digital data in much the same way it is processed in a computer, it is only necessary to insert desired instructional codes in the computed data in order to generate a plot. The CalComp plotter, however, cannot use computer data as it is processed, rather a programming operation must come into play. The computer data must be examined and a series of plotter codes generated in order to produce a plot.

A Series 3110/3120/3130 DATAPLOTTER will move from a point defined by nine binary characters to a new point defined by nine new binary characters and this movement can cover as much as five inches. Essentially, a DATAPLOTTER then can produce a five-inch line with 18 characters. A CalComp plotter can only produce a .010" diagonal per character. This then means that to produce the same five-inch line the DATAPLOTTER produced would take 500 characters (5/.01).

If we drop the excursion down to a one-inch line, the DATAPLOTTER still requires 18 characters, but the CalComp requirements drop to 100 characters. This reduction continues until the DATAPLOTTER and CalComp character requirements become equal at line lengths between 1/4 and 1/8-inch. This then would

indicate that for contour plotting or smooth data plotting, CalComp has an advantage; but not necessarily so -- the quality of line produced by the DATAPLOTTER can be a determining factor. The DATAPLOTTER line is smoother, cleaner and more accurate than any line produced by any plotter.

INPUT DEVICES

Like the Dymec unit and the Miniplotter, the CalComp plotter can operate from magnetic tape input; the 3110/3120/3130 DATAPLOTTER does not. The 3500 DATAPLOTTER with magnetic tape input is priced to be competitive with any of these units sold with magnetic input; the 3500 has the distince advantage of offering a 30 by 30-inch plotting board as standard. For the purpose of this discussion, we will limit the input devices to punched tape, cards and computers. This is essentially the key to our approach, since our off-line features are not readily available to CalComp or Dymec. Card and paper tape input are offered by Benson-Lehner on the Miniplotter, but no information is available as to it being a reality.

Advantages

The punched tape input and card input capabilities of the DATAPLOTTER are a great advantage. Since a minimum of characters are needed on tape to produce a line on the DATAPLOTTER, the amount of tape needed is reduced. Both the Dymec unit and CalComp unit have limitations in that both require continuous data to produce curves. The CalComp unit as stated can only advance in increments of .010"; the Dymec unit needs 25 data points per inch to draw a line. This means 300 characters. The Dymec unit is essentially a contour plotter.

Based on the number of characters required and the need for continuous sequential operation, it would appear that card input is neither practical or possible with Dymec or CalComp units.

ON-LINE

As can be seen by the attached description and figure, the 3130 on-line DATAPLOTTER has a number of attractive features.

Since computers vary in output capabilities, the 3130 outline is intended to serve as a guide to what computers it will readily operate from. If the computer is capable of producing those signals which are called for in the outline, it is safe to say the 3130 is readily compatible. The format required is essentially the same as that required for punched tape input. Variations are allowed, but the basic format should serve as a guide.

Advantages

The DATAPLOTTER does not offer the "software" that the competition offers, but at the same time, the programming requirements are not as stringent. The 3130 will operate with computer data as it is processed and it does not require the output storage that the Dymec and CalComp units require.

COMPARISON

Input	Dymec	B/L	EAI
Magnetic Tape	Yes	Yes	No
Punched Tape	Not Offered	Yes	Yes
Cards	? Offered	Yes	Yes
Keyboard	? Offered	Not Offered	Yes
Accuracy			
Line	.2%	.2%	.075%
Point	.15%	.2%	.075%
Repeatability	.10%	Not Quoted	.03%
Speed			
Line	4 in./sec.	60/min. 100/min.	40 Long 70 Short
Point	Not Quoted	200 points/min.	120 points/min.
Data Range			
Binary	4096	Not Quoted	4095
BCD	±9999	±999	±999
Scale Factor	Fixed	10 to 400 counts/in.	200 to 2000 counts full board
Board Offset	Not Quoted	Any Spot on Board	Plus or Minus 1-1/2 Full Board
Data Offset	Not Quoted	Not Quoted	±999

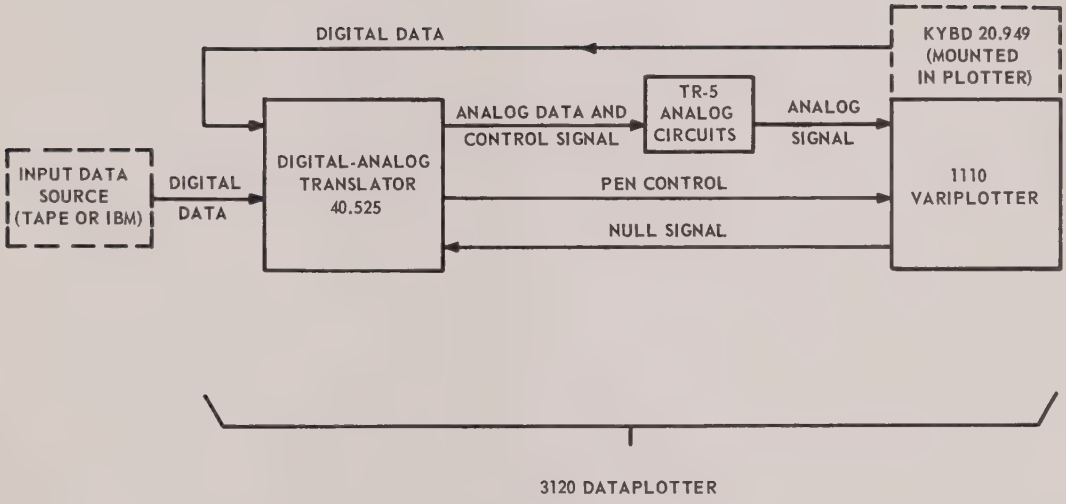


Figure 1. 3120 DATAPLOTTER System, Block Diagram

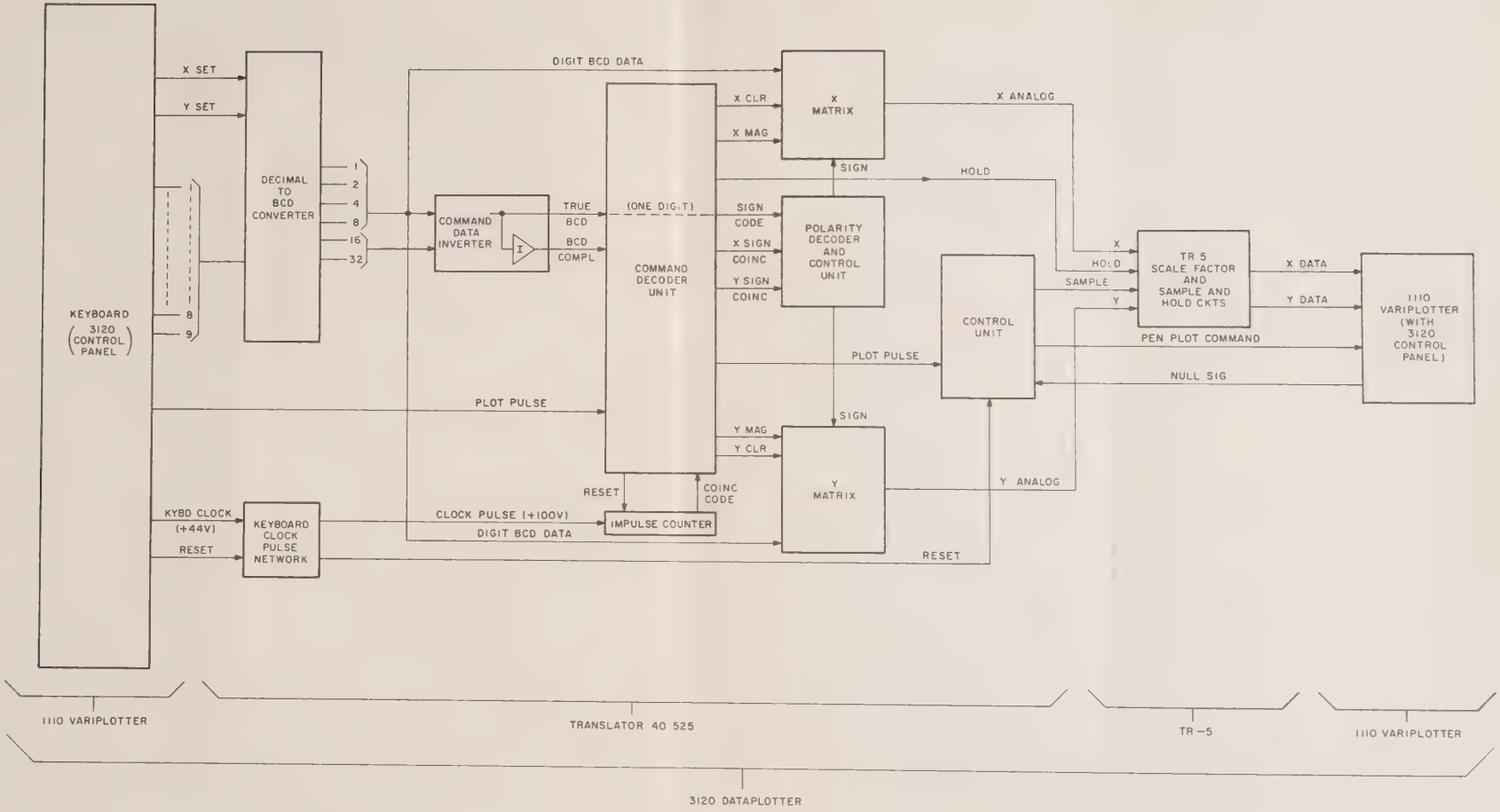


Figure 2.
DATAPLOTTER Block Diagram with Keyboard Input

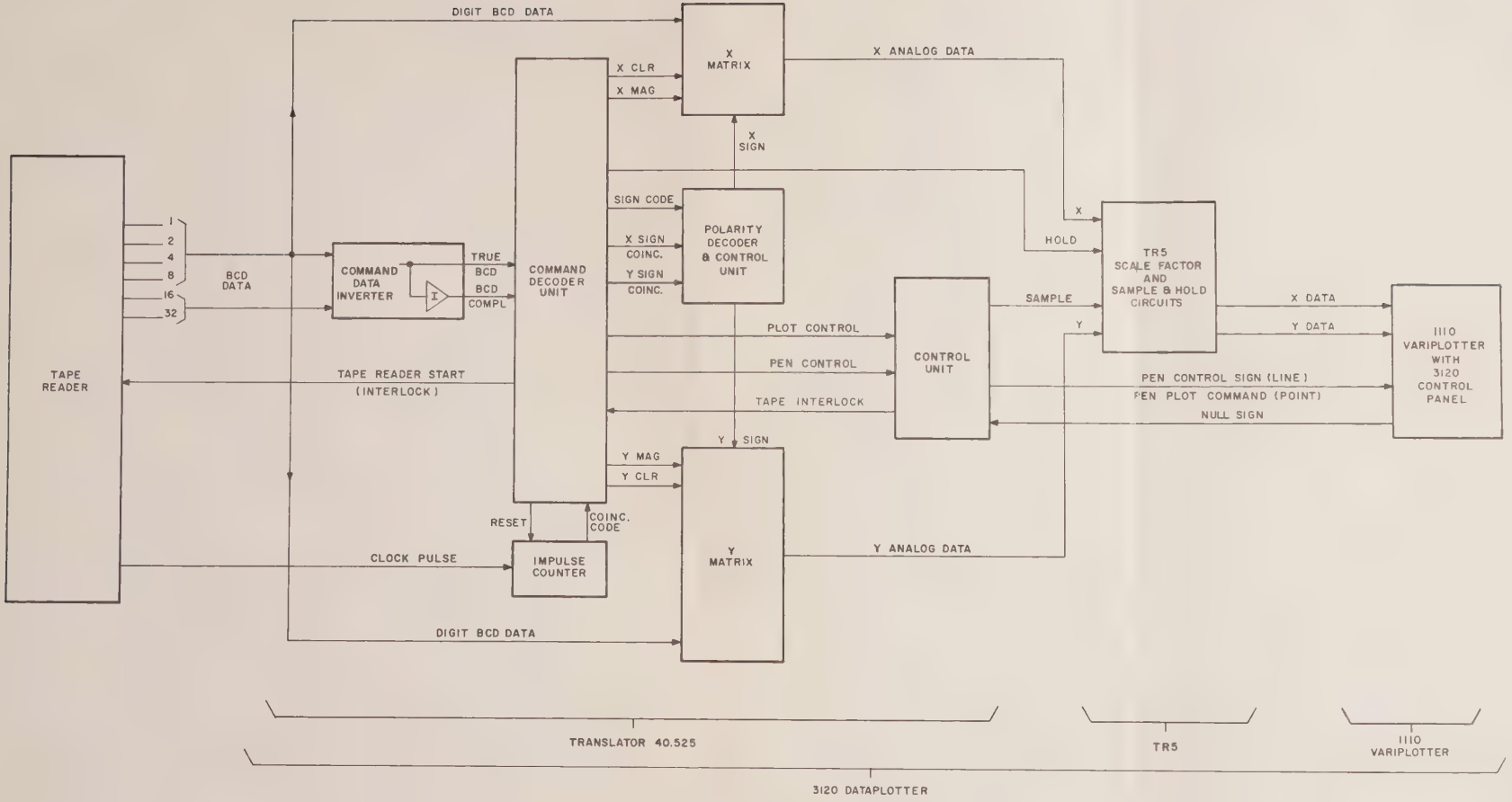


Figure .

DATAPLOTTER Block Diagram with Tape Reader Input

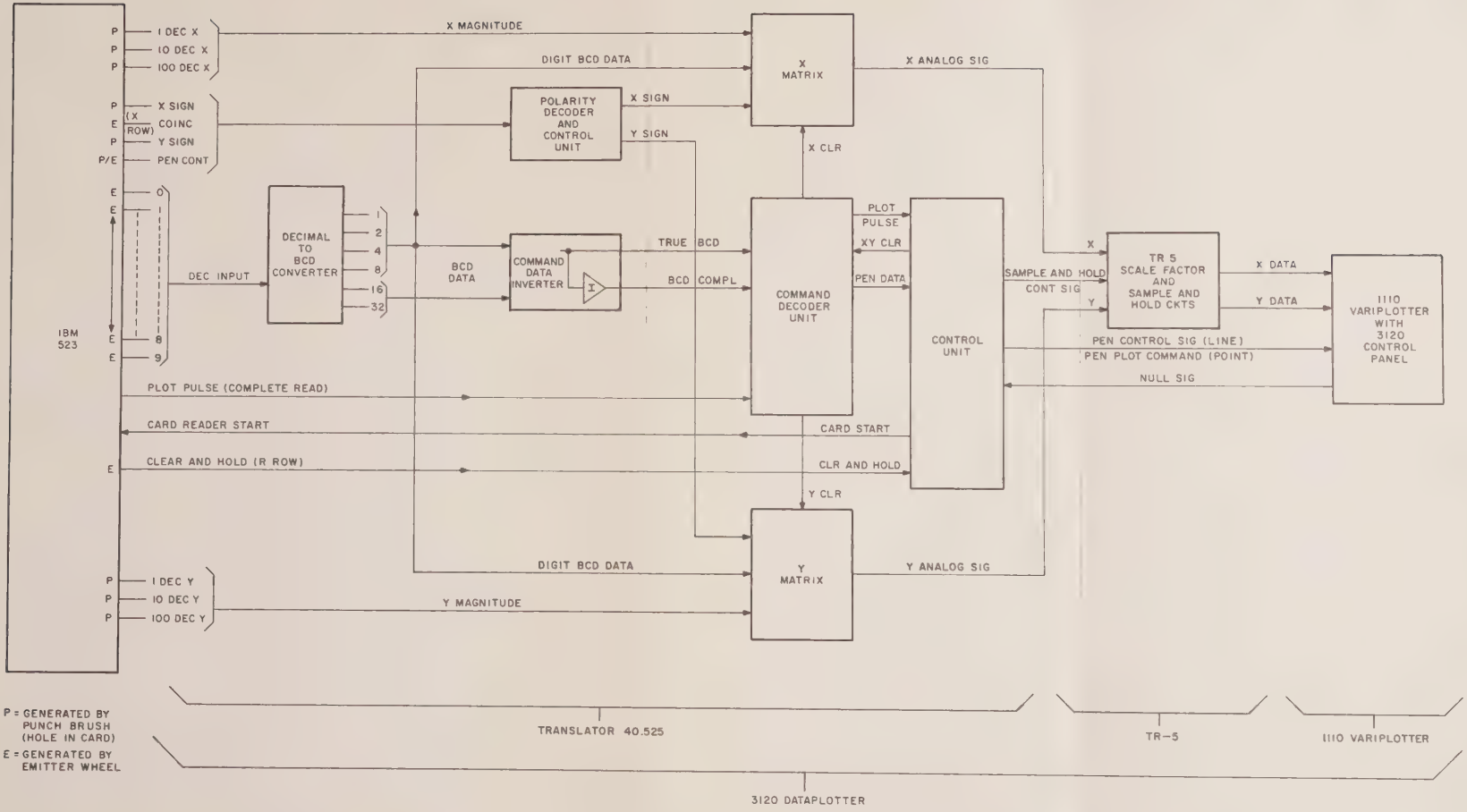


Figure 4.

DATAPLOTTER Block Diagram with Card Reader Input

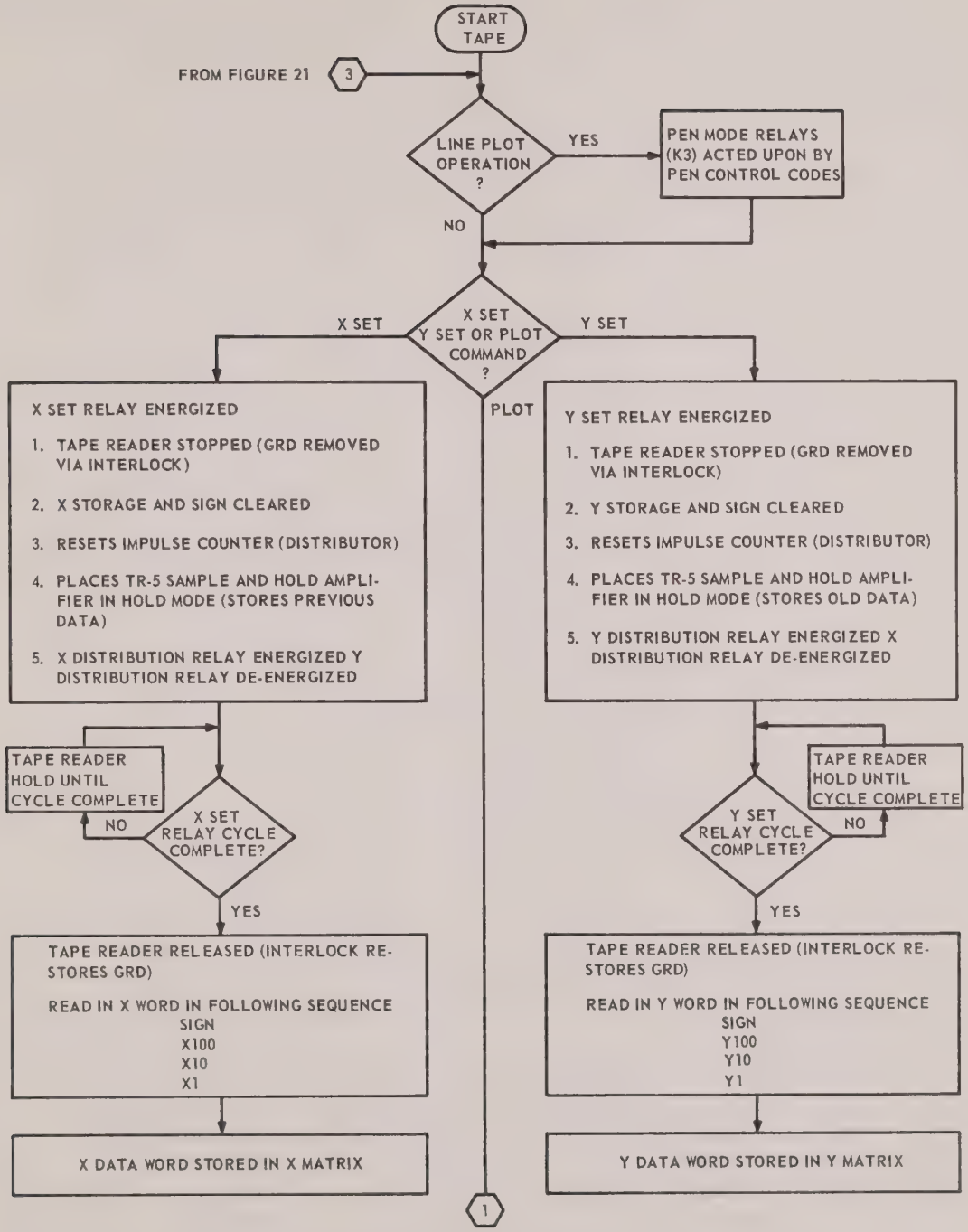

START TAPE
FROM FIGURE 21
3
LINE PLOT OPERATION ?
YES
PEN MODE RELAYS (K3) ACTED UPON BY PEN CONTROL CODES
NO
X SET Y SET OR PLOT COMMAND ?
X SET
Y SET
PLOT
X SET RELAY ENERGIZED
1. TAPE READER STOPPED (GRD REMOVED VIA INTERLOCK)
2. X STORAGE AND SIGN CLEARED
3. RESETS IMPULSE COUNTER (DISTRIBUTOR)
4. PLACES TR-5 SAMPLE AND HOLD AMPLIFIER IN HOLD MODE (STORES PREVIOUS DATA)
5. X DISTRIBUTION RELAY ENERGIZED Y DISTRIBUTION RELAY DE-ENERGIZED
Y SET RELAY ENERGIZED
1. TAPE READER STOPPED (GRD REMOVED VIA INTERLOCK)
2. Y STORAGE AND SIGN CLEARED
3. RESETS IMPULSE COUNTER (DISTRIBUTOR)
4. PLACES TR-5 SAMPLE AND HOLD AMPLIFIER IN HOLD MODE (STORES OLD DATA)
5. Y DISTRIBUTION RELAY ENERGIZED X DISTRIBUTION RELAY DE-ENERGIZED
TAPE READER HOLD UNTIL CYCLE COMPLETE
NO
X SET RELAY CYCLE COMPLETE?
YES
TAPE READER HOLD UNTIL CYCLE COMPLETE
NO
Y SET RELAY CYCLE COMPLETE?
YES
TAPE READER RELEASED (INTERLOCK RESTORES GRD)
READ IN X WORD IN FOLLOWING SEQUENCE
SIGN
X100
X10
X1
TAPE READER RELEASED (INTERLOCK RESTORES GRD)
READ IN Y WORD IN FOLLOWING SEQUENCE
SIGN
Y100
Y10
Y1
X DATA WORD STORED IN X MATRIX
Y DATA WORD STORED IN Y MATRIX
1

Figure 5. 3120 DATAPLOTTER Flow-Diagram, Tape Input (Part I)

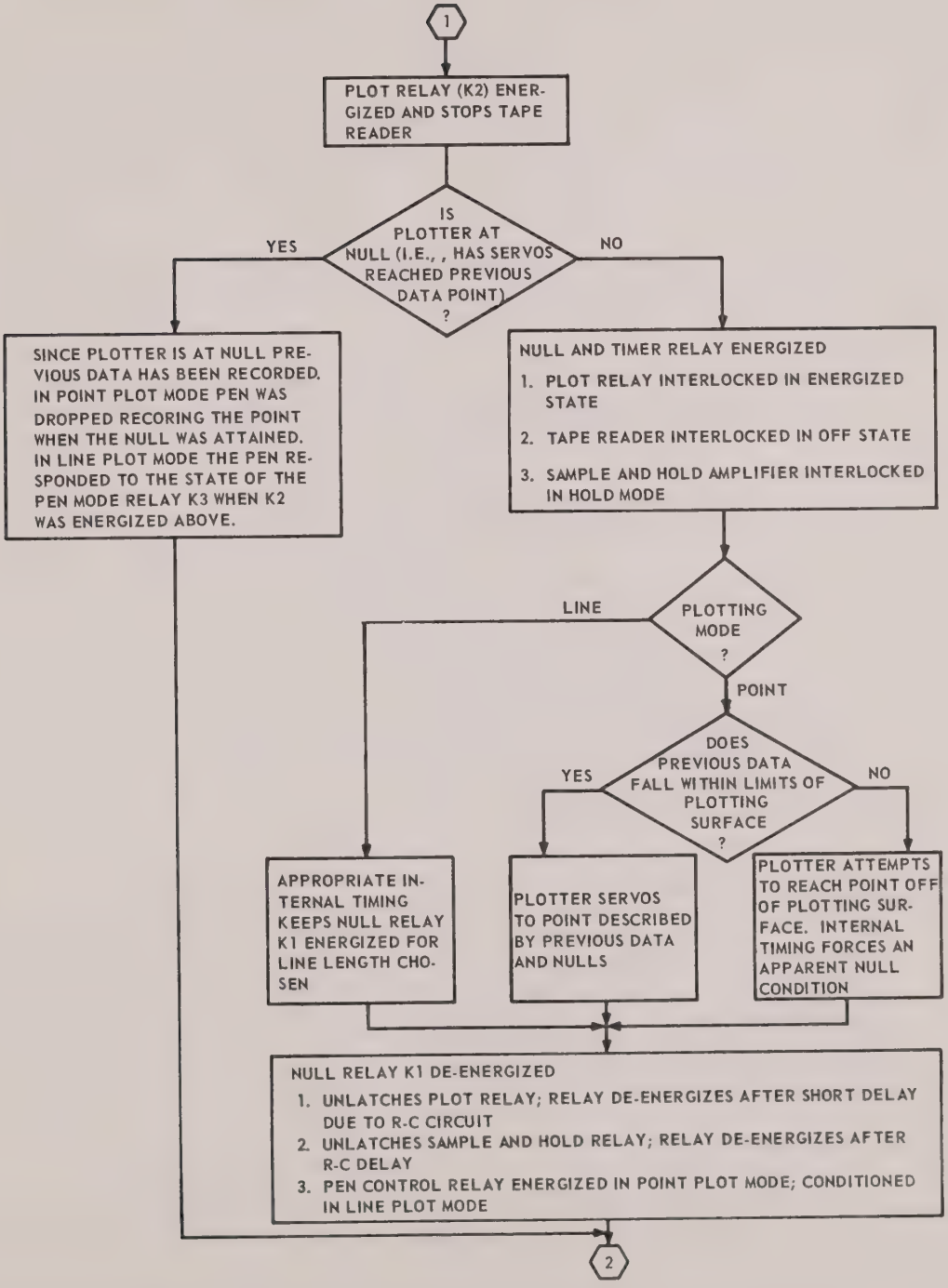

1
PLOT RELAY (K2) ENERGIZED AND STOPS TAPE READER
IS PLOTTER AT NULL (I.E., , HAS SERVOS REACHED PREVIOUS DATA POINT) ?
YES
NO
SINCE PLOTTER IS AT NULL PREVIOUS DATA HAS BEEN RECORDED. IN POINT PLOT MODE PEN WAS DROPPED RECORING THE POINT WHEN THE NULL WAS ATTAINED. IN LINE PLOT MODE THE PEN RESPONDED TO THE STATE OF THE PEN MODE RELAY K3 WHEN K2 WAS ENERGIZED ABOVE.
NULL AND TIMER RELAY ENERGIZED
1. PLOT RELAY INTERLOCKED IN ENERGIZED STATE
2. TAPE READER INTERLOCKED IN OFF STATE
3. SAMPLE AND HOLD AMPLIFIER INTERLOCKED IN HOLD MODE
PLOTTING MODE ?
LINE
POINT
DOES PREVIOUS DATA FALL WITHIN LIMITS OF PLOTTING SURFACE ?
YES
NO
APPROPRIATE INTERNAL TIMING KEEPS NULL RELAY K1 ENERGIZED FOR LINE LENGTH CHOSEN
PLOTTER SERVOS TO POINT DESCRIBED BY PREVIOUS DATA AND NULLS
PLOTTER ATTEMPTS TO REACH POINT OFF OF PLOTTING SURFACE. INTERNAL TIMING FORCES AN APPARENT NULL CONDITION
NULL RELAY K1 DE-ENERGIZED
1. UNLATCHES PLOT RELAY; RELAY DE-ENERGIZES AFTER SHORT DELAY DUE TO R-C CIRCUIT
2. UNLATCHES SAMPLE AND HOLD RELAY; RELAY DE-ENERGIZES AFTER R-C DELAY
3. PEN CONTROL RELAY ENERGIZED IN POINT PLOT MODE; CONDITIONED IN LINE PLOT MODE
2

Figure 6. 3120 DATAPLOTTER Flow-Diagram, Tape Input (Part II)

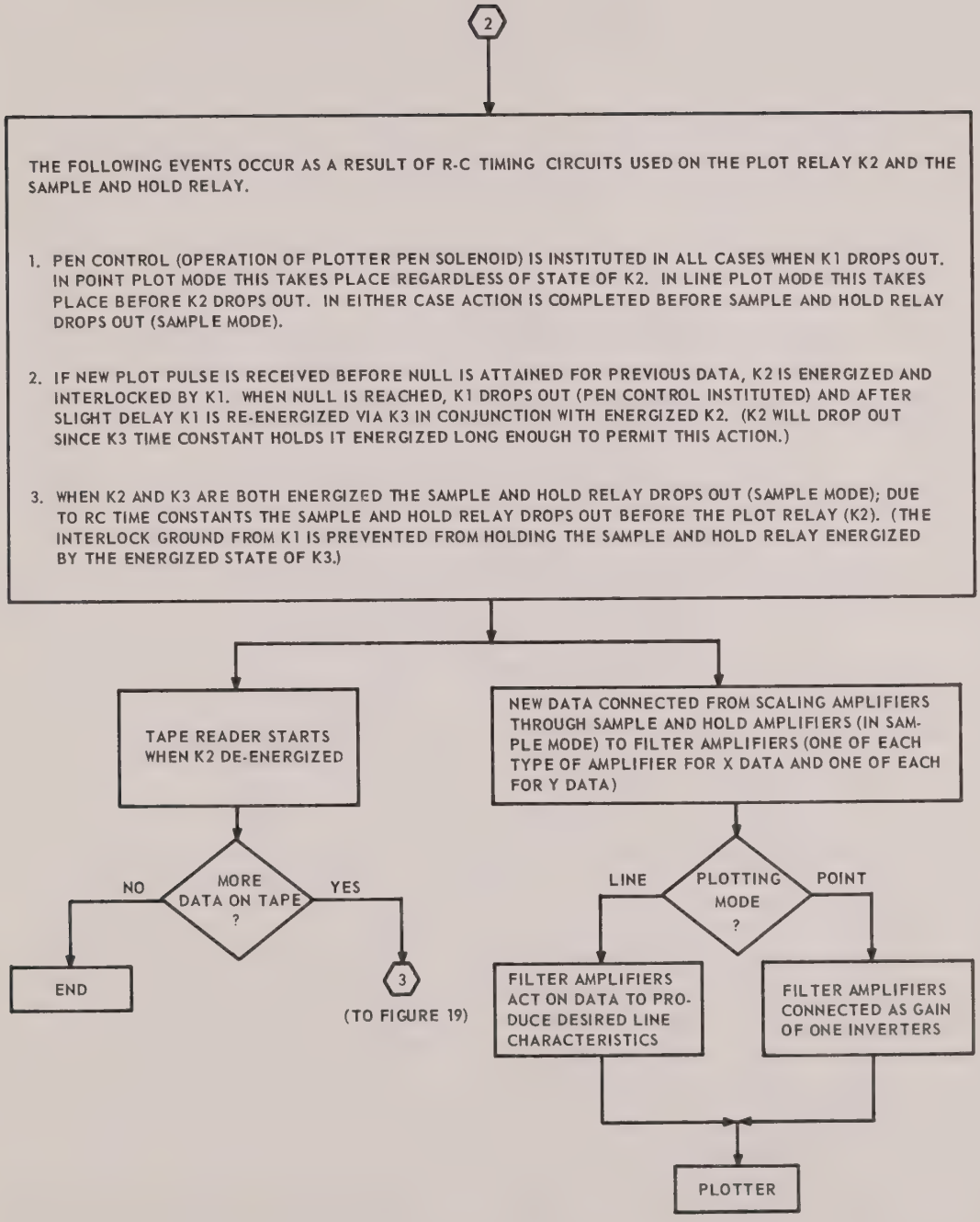

2
THE FOLLOWING EVENTS OCCUR AS A RESULT OF R-C TIMING CIRCUITS USED ON THE PLOT RELAY K2 AND THE SAMPLE AND HOLD RELAY.
1. PEN CONTROL (OPERATION OF PLOTTER PEN SOLENOID) IS INSTITUTED IN ALL CASES WHEN K1 DROPS OUT. IN POINT PLOT MODE THIS TAKES PLACE REGARDLESS OF STATE OF K2. IN LINE PLOT MODE THIS TAKES PLACE BEFORE K2 DROPS OUT. IN EITHER CASE ACTION IS COMPLETED BEFORE SAMPLE AND HOLD RELAY DROPS OUT (SAMPLE MODE).
2. IF NEW PLOT PULSE IS RECEIVED BEFORE NULL IS ATTAINED FOR PREVIOUS DATA, K2 IS ENERGIZED AND INTERLOCKED BY K1. WHEN NULL IS REACHED, K1 DROPS OUT (PEN CONTROL INSTITUTED) AND AFTER SLIGHT DELAY K1 IS RE-ENERGIZED VIA K3 IN CONJUNCTION WITH ENERGIZED K2. (K2 WILL DROP OUT SINCE K3 TIME CONSTANT HOLDS IT ENERGIZED LONG ENOUGH TO PERMIT THIS ACTION.)
3. WHEN K2 AND K3 ARE BOTH ENERGIZED THE SAMPLE AND HOLD RELAY DROPS OUT (SAMPLE MODE); DUE TO RC TIME CONSTANTS THE SAMPLE AND HOLD RELAY DROPS OUT BEFORE THE PLOT RELAY (K2). (THE INTERLOCK GROUND FROM K1 IS PREVENTED FROM HOLDING THE SAMPLE AND HOLD RELAY ENERGIZED BY THE ENERGIZED STATE OF K3.)
TAPE READER STARTS WHEN K2 DE-ENERGIZED
NEW DATA CONNECTED FROM SCALING AMPLIFIERS THROUGH SAMPLE AND HOLD AMPLIFIERS (IN SAMPLE MODE) TO FILTER AMPLIFIERS (ONE OF EACH TYPE OF AMPLIFIER FOR X DATA AND ONE OF EACH FOR Y DATA)
MORE DATA ON TAPE ?
NO
YES
END
3
(TO FIGURE 19)
PLOTTING MODE ?
LINE
POINT
FILTER AMPLIFIERS ACT ON DATA TO PRODUCE DESIRED LINE CHARACTERISTICS
FILTER AMPLIFIERS CONNECTED AS GAIN OF ONE INVERTERS
PLOTTER

Figure 7. 3120 DATAPLOTTER Flow-Diagram, Tape Input (Part III)

COMPUTER INTERFACE REQUIREMENTS

FOR THE

3130 DATAPLOTTER SYSTEM

1. Output Lines from Computer

   A. Data Lines to be in BCD Code

      Output 1
      Output 2
      Output 4
      Output 8
      Output A (16)
      Output B (32)

      These are logic levels which are held "on" until the DATAPLOTTER, through the Service Request line, calls for the next character.

   B. Service Response

      This line signals the 3130 DATAPLOTTER that data is on the lines and is available to the DATAPLOTTER.

      It will have a "true" level from the time it is initiated within the computer until the turn off of the Service Request line.

   C. ±GND

   D. Interlock and DC Lines as Dictated by Computer

2. Input Lines to the Computer

   Only one line required:

   Service Request

   This line will have a "true" level whenever the DATAPLOTTER is ready to receive the next character.

3. Output from Computer

   The sequence of events and controls when transmitting characters from the computer to be as follows:

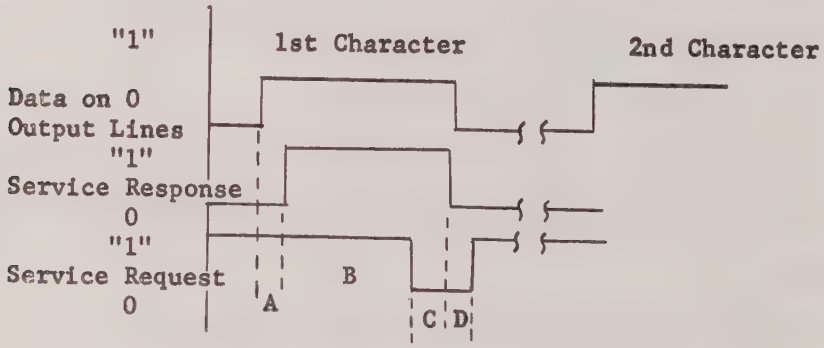
A. The computer places the character on the data lines.

B. The computer sends a Service Response to indicate the data is available.

C. If the Service Request line is "true", the 3130 accepts the data and drops its Service Request line to the false or zero ("0") state. When it is ready to receive the next character, the Service Request line is again raised to the "true" level.

D. Steps A to C are repeated until the entire block of information has been transmitted.

Timing Sequence:



Time A - Determined by computer

B - Determined by 3130 DATAPLOTTER

C - Determined by computer

D - Determined by 3130 DATAPLOTTER

4. Logic Levels and Drive Requirements

Binary "1" True State = +12 volts

Binary "0" False State = 0 volts

These are the levels required for a standard buffer input. Line terminations, however, are generally dictated by the computer to which the 3130 is being interfaced. Therefore, depending on the computer used, the standard buffer is replaced by the required line terminators as specified by the computer interface requirements. Interface requirements as to line terminations must be known prior to placement of order.

A. Cabling to Computer

Cabling from the 3130 to the customer's computer is furnished by EAI. Length of cable normally furnished is approximately twelve (12) feet.

Cable length to customer requirements can be furnished. Type of connector at computer "end" and whether the signal lines are to be twisted pair or single ended is again dictated by the computer and is to be specified prior to placement of order.

5. Format

Identical word format is used for both tape reader and computer operation.

Typical Sequence:

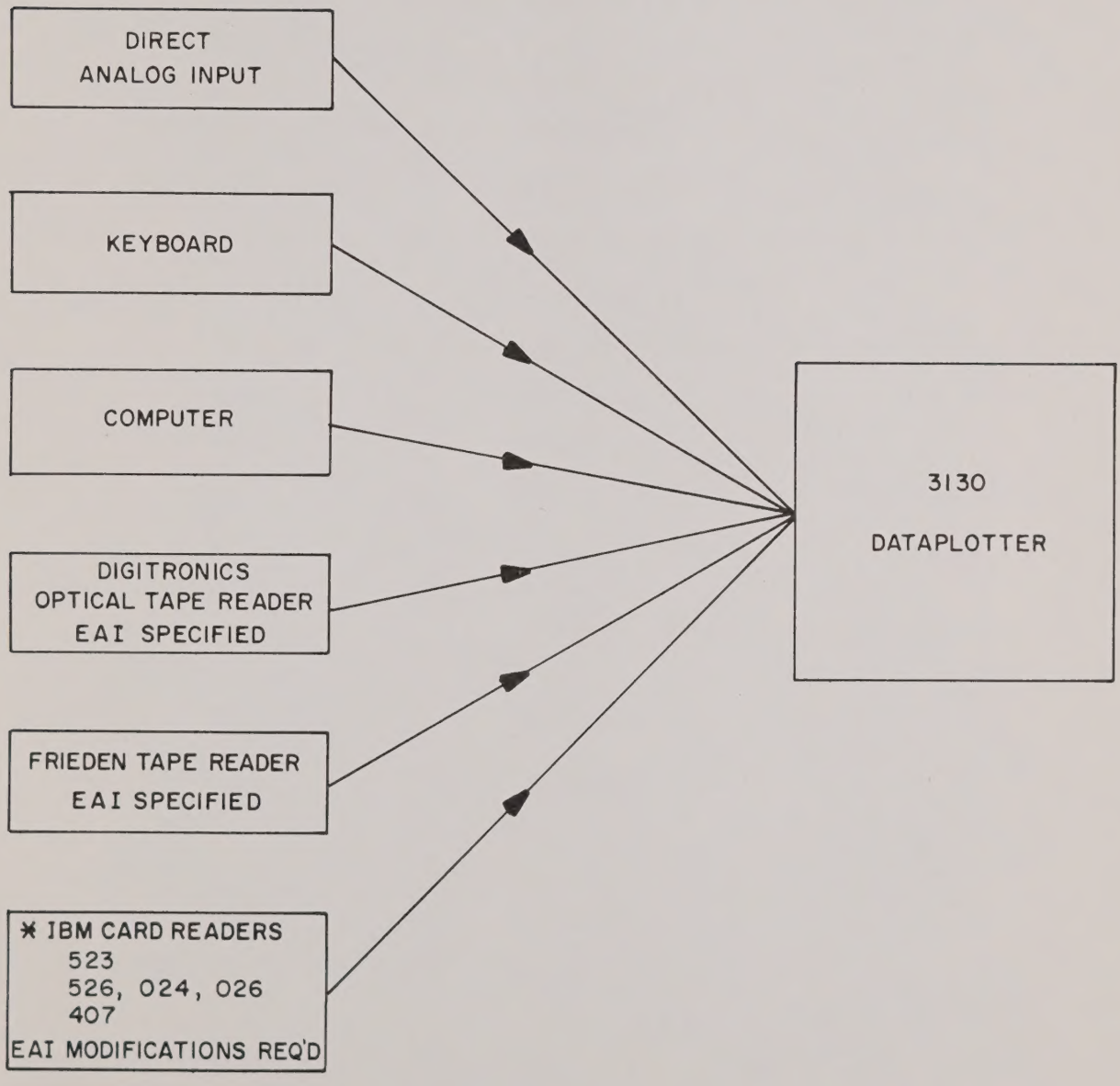
	A	Pen Up or Pen Down*
	B	X Set
	C	X Sign - BCD "1" represents minus, BCD "0" represents plus
One Complete X,Y	D	X Data (3 decimal) - 3 BCD characters - most significant first
Coordinate Point	E	Y Set
Plot	F	Y Sign
	G	Y Date (3 decimal) - 3 BCD characters - most significant first
	H	Plot

*Pen Up or Pen Down used in line drawing mode only and precedes the point to which it applies.

NOTE: Once the Pen-Down command has been initiated to start line drawing, it is only necessary to include Pen Control command when it is desired to raise the pen.

Control characters, pen up, pen down, X set, Y set and plot can be any unique alphanumeric characters that can be furnished by the customer. This information is required by EAI prior to placement of order. The digit zero (0) is assumed to be represented by the absence of the 8 4 2 1 bits. If the digit zero (0) is represented by BCD 8 2, then this must be known by EAI for proper data interpretation.

INPUT OPTIONS
FOR
3130 DATAPLOTTER SYSTEM



GENUINE PRESSBOARD